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Efficacy of ethanolic and aqueous extract of some plants on some biological aspects of cowpea beetle *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae) – A comparative study

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The present study included to know about the effectiveness of steep chickpea *Cicer arietinum* L. seeds with ethanolic and aqueous extracts of the Oleander *Nerium oleander*, Basil *Ocimum basilicum*, Chinaberry *Melia azedarach*, and Natgrass *Cyperus rotundus* leaves with four concentration (0.5, 1.0, 2.5, 5.0) % on some biological sides of the cowpea beetle *Callosobruchus maculatus* (Fab.). The present study showed the superiority of leaves extracts of Oleander and Chinaberry as compared with leaves extracts of Basil and Natgrass, as well as the superiority of aqueous extracts as compared with ethanolic extracts of the present study plant's leaves on some biological sides of the cowpea beetle *C. maculatus* (Fab.). Also, the present study showed that the least number of laid eggs was recorded at a concentration of 1.0% of the ethanolic extract of the chinaberry with several 31.5 eggs, the least percentage of hatched eggs was recorded in the aqueous extract of chinaberry at a concentration of 5.0% with a percentage of 64.8%, the highest larval stage period was recorded at a concentration of 5.0% of the ethanolic extract of the chinaberry with a period of 19.8 days. Total mortality (100%) in the larval stage was achieved with a concentration of 5.0% of the aqueous extracts of the Oleander and Chinaberry. The highest pupal stage period was recorded at 5.0% of the ethanolic extract of the chinaberry at 14.8 days. The highest mortality in the pupal stage was recorded at a concentration of 2.5 % of the aqueous extract of the chinaberry with a percentage of 23.0%. The least number of emerged adults in the first generation and least percentage of productivity were recorded at a concentration of 5.0 % of the aqueous extracts of the Oleander and Chinaberry, with several 0.0 adults and a percentage of 0.0%, respectively.The study also showed that the germination percentage of Chickpea seeds was not significantly affected when it was treated with different concentrations of ethanolic and aqueous extracts of the present study plants' leaves.
Keywords: Bqueous extract, biological aspects, *callosobruchus maculatus*, ethanolic extract.

INTRODUCTION

Chickpea *Cicer arietinum* L. is an indispensable crop grown in parts of Africa, Asia and the Middle East many years ago (Tesfu and Emana, 2013). It is considered an important leguminous crop throughout the world that has been grown to get dry seeds, and it is used frequently by human beings as food because it provides high-quality protein and possesses an essential source of energy which is about 416 calories/ 100g (Vance, 2001), along with carbohydrate (52-70%)(Bhalla *et al*., 2008). In addition, it plays a primary economic role in fixing atmospheric nitrogen, which consequently decreases agricultural costs through the minimization of fertilizer use and reducing environmental contamination, and increasing soil fertility (Umeozor, 2005). Chickpea *C. arietinum* L. seeds are exposed to attack by the cowpea beetle *Callosobruchus maculatus* (Fab.), which is considered the most spread and dangerous pest than other genera which belong to Bruchidae, and it is considered a major pest in both the field and the storage (Southgate, 1979). It is a major cause of the great loss of grain legumes in storage. It is frequently reported that 10% of legumes and cereals are minimally lost worldwide after reaping (Boxall *et al*., 2002). Primary infection transfers with seeds from field to storage, and then the infection will develop within the seeds and become more damaging when the availability of favorable conditions for the cowpea beetle *C. maculatus* (Fab.) as well as the ability of cowpea beetle *C. maculatus* (Fab.) adult to fly making its transition from the storage to the field and vice versa be easy (Raina, 1971). Cowpea beetle *C. maculatus*

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(Fab.) that attacks Chickpea *C. arietinum* L. remarkably influences qualitatively and quantitatively, and these crops lose their germinating capacity as well (Kumar *et al*., 2009). Control of stored-product insects such as cowpea beetle *C. maculatus* (Fab.) has centered mainly on the use of chemical insecticides; however, the use of these chemicals has caused dangerous drawbacks on the environment and toxicity dangers on non-target organisms, including the users of these chemicals and their animals (Isman, 2006), and the growing problems such as the development of genetically resistant strains of insects (Daglish, 2008). These problems pushed the research toward investigating alternative eco-friendly, cheaper insect pest control methods (Pearce, 1997). One possible alternative control method is the exploitation of plant extracts as agents of pest control without or with minimal side effects against mammals, birds, and other animals, in addition to the possibility of decomposing it quickly into non-toxic components when it is exposed to sunlight, as well as, eco-friendly and harmless on microorganisms (Bläske and Hertel, 2001). This research endeavored to compare the efficacy of ethanolic and aqueous extracts of the Oleander *Nerium oleander*, Basil *Ocimum basilicum*, Chinaberry *Melia azedarach*, and Natgrass *Cyperus rotundus* leaves on some biological sides of the cowpea beetle *C. maculatus* (Fab.) which include: number of laid eggs per female, percentage of hatched eggs, larval and pupal stages period, mortality percentages of larvae and pupae, number of emerged adults, and percentage of productivity. Also, it destroys natural enemies used to control insect pests and the increasing application costs (Isman, 2008). This insect pest was chosen due to its economic importance and the fact that it causes serious damage to legumes.

MATERIALS AND METHODS

Cowpea beetle *C. maculatus* (Fab.) had been obtained from the original stock culture where chickpeas *C. arietinum* L. had been used as media for the cowpea beetle *C. maculatus* (Fab.) in glass jars (14 × 8 cm) and were covered with muslin cloth held with rubber bands and maintained at a temperature of 30±2 ºC and relative humidity of 50±5% at complete darkness in the laboratory. This insect pest had been identified depending on Rees (Ress, 2007). A concentration of 100% (stock extracts) had been obtained for ethanolic extracts of study plant leaves according to the method of Ladd and others (Ladd *et al*., 1978) and for aqueous extracts according to the method of Rios and others (Rios *et al*., 1987). The extracts were diluted to provide the required concentrations of 0.5, 1.0, 2.5, and 5.0%. The diluted concentrations of extracts were mixed separately with 50g of undamaged and arable chickpea *C. arietinum* L. seeds for one hour in order to be saturated with extracts to represent the treated seeds; on the other hand, the distilled water and ethanolic had were mixed separately with it to represent the untreated (control) seeds (Attri and Prasad, 1980), then the seeds had been put on Whatman, No. 1, filter paper disks in the incubator at 25 ºC to be dry. After complete dryness of the seeds, four replicates were made for each extract and concentration along with controls in plastic cups, and each one contains 20g chickpea *C. arietinum* L. seeds and one pair of newly emergence adult cowpea beetles *C. maculatus* (Fab.). These plastic cups were covered with muslin cloth held with rubber bands and were kept in the incubator at 30±2 ºC and 50±5% r. h. The monitoring had been made daily to record the data about the number of laid eggs per female, percentage of hatched eggs, larval and pupal stages period, number of emerged adults, percentage of productivity, and mortality percentages of larvae and pupae had been corrected using Abbott's formula (Abbott, 1925) as follows:

Corrected percentage of mortality

$$= \frac{Mortality\%\ of\ treatment - Mortality\%\ of\ control}{100 - Mortality\%\ of\ control} \times 100$$

The percentage of productivity was calculated using the following equation (Giga *et al*., 1993).

Percentage of adult productivity

$$= \frac{\text{Number of emerged adults}}{\text{Total number of hatched eggs}} \times 100$$

In order to determine the effectiveness of the extracts on germination percentage for chickpea *C. arietinum* L. seeds were saturated separately with extracts concentrations, three replicates were made for each extract concentration along with controls where seeds had been saturated separately with the distilled water only, and ethanolic only in sterilized Petri dishes. Ten seeds were placed on a thin layer of cotton in each Petri dish and saturated with distilled water. The Petri dish that contained the seeds was put in the incubator at 10 ºC and 65 % r. h. for eight days to determine the germination percentage (I.S.T.A., 1999). Finally, the germination percentage was calculated using the following equation (Haile, 2015):

$$\text{Germination percentage} = \frac{No.of\ germinated\ seeds}{Total\ no.of\ seeds} \times 100$$

The experimental design for all experiments was a complete randomized design (CRD) with a two-factor factorial. The first factor was the different extract concentrations, and the second was the extract type (Wijayaratne and Fields, 2010). Data entry and analysis were made using an SPSS v. 11.5 statistical software package (SPSS Inc, 2011). An analysis of variance (ANOVA) was used to observe the effects of the factors used in the experiments. The significance of mean differences between control and treatments was statistically compared employing Duncan's multiple range test at the 0.05 significance level.

RESULTS

The results in Table 1. showed that the number of laid eggs was unaffected by the ethanolic extract concentrations, even if there exists a considerable difference in the number of laid

eggs among the treatments used. However, in the treatment of ethanolic extract of the Oleander, the number of laid eggs was 71.0 eggs at the concentration of 0.5%, then the number of laid had decreased to 45.5 eggs when the concentration was 1.0%. The number of laid had increased to 46.8 and 56.5 eggs when the concentration was 2.5 and 5.0%, respectively, whereas the number of laid eggs was 47.8 eggs at the concentration of 0.5%, then it had increased to 72.3 eggs when the concentration was 1.0%. It had decreased to 41.0 and 42.5 eggs when the concentration was 2.5 and 5.0%, respectively, in the treatment of ethanolic extract of the Basil, but in the treatment of ethanolic extract of the chinaberry, the number of laid eggs was 53.8 eggs at the concentration of 0.5%, then it had been decreased to 31.5 eggs when the concentration was 1.0%. After that, it had been increased to 65.8 eggs when the concentration was 2.5 %; then it had been decreased to 47.3 eggs when the concentration was 5.0%, whereas the number of laid eggs was 71.8 eggs at the concentration of 0.5%, then it had been decreased to 56.0 eggs when the concentration was 1.0%, then it had been decreased to 40.0 eggs when the concentration was 2.5 %, then it had been increased to 44.3 eggs when the concentration was 5.0% in the treatment of ethanolic extract of the Natgrass; also the results in Table 1. showed that there was no considerable difference in mean of the number of laid eggs between the total average of the treatments and control. The percentage of hatched eggs was affected by the ethanolic extract concentrations, and there exists a considerable difference in the percentage of hatched eggs among the treatments; the maximum percentage of hatched eggs was 98.5% in control, while the least one was obtained with a concentration of 5.0% of the ethanolic extract of the chinaberry with a percentage of hatched eggs of 70.8%. Also, there exists a considerable difference in the percentage of hatched eggs among a total average of the treatments and control; the least percentage of hatched eggs was recorded in the ethanolic extract of the chinaberry with a percentage of 80.5%, followed by the ethanolic extract of the Oleander with a percentage of 81.6%, while the highest percentage of hatched eggs was achieved in control with a percentage of 98.5% followed by the of ethanolic extract of the Natgrass and the Basil with the percentages of 88.1 and 86.1%, respectively. An inverse relationship existed between the percentage of hatch eggs and the concentrations used. In contrast, the percentages of hatch eggs were 90.8, 85.3, 78.3 and 72.0% in the treatment of ethanolic extract of the Oleander, and 94.5, 91.0, 83.8 and 75.3% in the treatment of ethanolic extract of the Basil, and 91.0, 83.5, 76.8 and 70.8% in the treatment of ethanolic extract of the chinaberry, and 95.3, 93,8, 86.8 and 76.5% in the treatment of ethanolic extract of the Natgrass at the concentrations of 0.5, 1.0, 2.5 and 5.0%, respectively. Also, the results in Table 1. showed that there exists a significant difference in the larval stage period between the treatments of ethanolic extracts concentrations and control (except the concentration of 0.5% of the ethanolic extract of the Natgrass and control were not significantly different in the larval stage period), and the larval stage period increased as the ethanolic extract concentration increased. Also, the larval stage periods among the treatments of ethanolic extracts concentrations, except for concentrations of 0.5 and 1.0% of the ethanolic extracts of the Oleander and the Chinaberry, were significantly different. There exists a considerable difference in the larval stage period between the treatments of ethanolic extracts and control; the highest larval stage period was recorded in the ethanolic extract of the chinaberry followed by the ethanolic extract of the Oleander, the Basil, and the Natgrass with a period of 17.3, 16.8, 14.1 and 13.5 days, respectively. The least larval stage period was recorded in control with 11.3 days. The results in Table 1. showed that the mortality of the larvae was affected by the ethanolic extract concentrations, and there exists a considerable difference in mortality of larvae among the treatments of ethanolic extracts concentrations, also between the treatments of ethanolic extracts and control. The larvae mortality increased as the ethanolic extract concentration increased. The highest larvae mortality was recorded in the ethanolic extract of the chinaberry, followed by the ethanolic extract of the Oleander, the Basil, and the Natgrass with a mortality of 37.0, 36.1, 25.8 and 21.8%, respectively. In comparison, the least larvae mortality was recorded in control, with a mortality of 3.5%. Moreover, there exists a considerable difference in the pupal stage period between the treatments of ethanolic extracts concentrations and control (except concentrations of 1.0 and 2.5% of the ethanolic extract of the Basil and concentrations 0.5 and 1.0% of the ethanolic extract of the Natgrass and control were not significantly different in the pupal stage period). The pupal stage period increased as the ethanolic extract concentration increased, except the pupal stage period at the ethanolic extract of the Oleander decreased from 13.0 days to 12.5 days as concentration increased from 0.5% to 1.0%. Moreover, there was no significant difference in the pupal stage period among the ethanolic extracts of the Basil and the Natgrass and control; the highest pupal stage period was recorded in the ethanolic extract of the chinaberry, followed by the ethanolic extract of the Oleander, the Natgrass and the Basil with a period of 13.4, 13.3, 11.2 and 11.0 days, respectively, while the least pupal stage period was recorded in control with a period of 10.5 days. Also, there is a considerable difference in mortality of pupae among the treatments of ethanolic extracts concentrations and between the treatments of ethanolic extracts and control. The pupae mortality increased as the ethanolic extract concentration increased. The maximum pupae mortality was recorded in the ethanolic extract of the chinaberry, followed by the ethanolic extract of the Oleander, the Basil, and the Natgrass with a mortality of 12.2, 10.2, 7.0 and 4.4%, respectively. In comparison, the least pupae mortality was recorded in control, with a mortality of 1.0%.

Table 1. The effect of ethanolic extracts of some plants and their concentrations on some biological aspects of cowpea beetle *C. maculatus* (Fab.).

The ethanolic extract of the	Conc. (%)	Mean of biological aspects							
		Number of laid eggs	percentage of hatched eggs (%)	Larval stage period (day)	Larvae mortality (%)	Pupal stage period (day)	Pupae mortality (%)	Number of emerged adults	percentage of productivity (%)
Oleander	0.5	71.0 a*	90.8 c	15.8 b-e	29.0 d	13.0 abc	5.5 ghi	43.1 c	60.9 f
N.oleander	1.0	45.5def	85.3 d	15.5 b-e	32.8 c	12.5 abc	8.3 efg	23.9 fgh	52.6 g
	2.5	46.8 c-f	78.3 e	17.3 abc	39.3 b	13.8 abc	11.8 cd	19.6 ij	41.9 j
	5.0	56.5 b	72.0 f	18.8 ab	43.3 a	14.0 ab	15.3 ab	19.5 ij	34.6 k
	Average	54.9 A	81.6 BC	16.8 A	36.1 A	13.3 A	10.2 AB	26.5 BC	47.5 C
Basil	0.5	47.8 b-f	94.5 b	12.5 ef	16.3 g	10.3 c	3.8 ijk	36.3 d	76.2 c
O. basilicum	1.0	72.3 a	91.0 c	13.3 def	19.5 f	10.5 bc	5.0 hij	50.2 b	69.6 d
	2.5	41.0 f	83.8 d	14.0 c-f	28.8 d	10.8 bc	8.5 efg	22.3 ghi	54.6 g
	5.0	42.5 ef	75.3 e	16.5 a-d	38.8 b	12.5 abc	10.8 cde	17.4 jk	41.1 j
	Average	50.9 A	86.1 BC	14.1 B	25.8 B	11.0 B	7.0 BC	31.6 BC	60.4 B
Chinaberry	0.5	53.8bcd	91.0 c	15.8 b-e	29.8 d	12.5 abc	7.3 fgh	31.8 e	59.3 f
M. azedarach	1.0	31.5 g	83.5 d	16.0 b-e	34.3 c	12.8 abc	10.8 cde	15.4 k	49.0 h
	2.5	65.8 a	76.8 e	17.5 abc	38.5 b	13.5 abc	13.0 bc	26.9 f	41.0 j
	5.0	47.3 b-f	70.8 f	19.8 a	45.5 a	14.8 a	17.8 a	14.9 k	31.7 l
	Average	49.6 A	80.5 C	17.3 A	37.0 A	13.4 A	12.2 A	22.3 C	45.2 C
Natgrass	0.5	71.8 a	95.3 b	11.8 f	12.5 h	10.8 bc	2.0 jk	58.6 a	81.7 b
C. rotundus	1.0	56.0 bc	93.8 bc	12.5 ef	16.8fg	10.8 bc	2.8 ijk	42.4 c	75.9 c
	2.5	40.0 f	86.8 d	14.3 c-f	24.0 e	11.5 abc	4.3 hij	25.2 fg	63.1 e
	5.0	44.3 ef	76.5 e	15.5 b-e	33.8 c	11.8 abc	8.8 def	20.4 hij	46.2 i
	Average	53.0 A	88.1 B	13.5 B	21.8 B	11.2 B	4.4 C	36.6 B	66.7 B
Control		51.5 b-e	98.5 a	11.3 f	3.5 i	10.5 bc	1.0 k	48.4 b	94.1 a
	Average	51.5 A	98.5 A	11.3 C	3.5 C	10.5 B	1.0 D	48.4 A	94.1 A

*Means followed by the same letters within a column do not significantly appear to be different (at the 0.05 significance level) as determined by Duncan's multiple range test.

Also, the results in Table 1. showed that there exists a considerable difference in the quantity of emerged adults among the treatments of ethanolic extracts concentrations except for concentrations of 2.5 and 5.0% of the ethanolic extract of the Oleander which was not significantly different in the number of emerged adults, the concentrations of 1.0 and 5.0% of the ethanolic extract of the chinaberry as well. Also, a significant difference exists in the number of emerged adults between the treatments of ethanolic extracts and control. The highest number of emerged adults was recorded in control, with several 48.4 adults. In contrast, the least number of emerged adults was recorded in the ethanolic extract of the chinaberry, followed by the ethanolic extract of the Oleander, the Basil, and the Natgrass with several 22.3, 26.5, 31.6, and 36.6 adults, respectively. There is a considerable difference in the percentage of productivity among the treatments of ethanolic extracts concentrations and the percentage of productivity between the treatments of ethanolic extracts and control. The highest percentage of productivity was recorded in control with a percentage of 94.1%, while the least percentage of productivity was recorded in the ethanolic extract of the chinaberry followed by the ethanolic extract of the Oleander, the Basil and the Natgrass with a percentage of 45.2, 47.5, 60.4 and 66.7%, respectively. The percentage of productivity decreased as the ethanolic extract concentration increased.

The results in Table 2 showed that the number of laid eggs was unaffected by the aqueous extract concentrations, even if there exists a considerable difference in the number of laid eggs among the treatments used. However, the number of laid eggs either decreases or increases as the aqueous extract concentration increases (i.e., there was no relationship between the number of laid eggs and aqueous extract concentration.). No significant difference exists in the number of laid eggs between the average of the treatments and the control. The percentage of hatched eggs was affected by the aqueous extract concentrations. There exists a considerable difference in the percentage of hatched eggs among the treatments, except the concentration of 0.5 % of the aqueous extract of the Natgrass and control were not significantly different; the percentage of hatched eggs decreased as the aqueous extract concentration increased (*i.e.*, there was an inverse relationship between the percentage of hatch eggs and the concentrations used.); also there exists a considerable difference in the percentage of hatch eggs between the average of the treatments and control, the maximum percentage of hatched eggs was recorded in control with a percentage of 97.3%, while the least percentage of hatched

Table 2. The effect of aqueous extracts of some plants and their concentrations on some biological aspects of cowpea beetle *C. maculatus* (Fab.).

The ethanolic extract of the	Conc. (%)	Mean of biological aspects							
		Number of laid eggs	percentage of hatched eggs (%)	Larval stage period (day)	Larvae mortality (%)	Pupal stage period (day)	Pupae mortality (%)	Number of emerged adults	percentage of productivity (%)
Oleander	0.5	48.8 jk*	92.5 bc	16.0 a-e	32.3 h	12.5 ab	8.8 de	27.8 f	57.2 f
N.oleander	1.0	55.8 efg	88.3 de	17.3 abc	41.5 fg	12.8 ab	13.3 c	24.9 g	44.8 i
	2.5	46.0 k	83.8 f	18.5 ab	55.8 d	13.8 a	21.0 a	13.4 j	29.3 k
	5.0	63.3 c	70.5 h	----	100 a	----	----	0.0 m	0.0 n
	Average	53.4 A	83.8 BC	17.3 A	57.4 AB	13.0 A	14.3 AB	16.6 C	32.8 CD
Basil	0.5	51.8 hij	91.8 bc	13.0 efg	15.3 j	10.0 b	5.5 fg	38.0 b	73.5 c
O. basilicum	1.0	59.3 d	87.5 de	14.5 c-g	26.8 i	10.5 ab	7.5 ef	35.1 d	59.3 e
	2.5	71.8 a	86.8 ef	16.5 a-d	43.3 ef	11.3 ab	11.8 c	31.1 e	43.4 i
	5.0	32.0 m	73.0 h	17.8 abc	67.0 b	13.0 ab	16.3 b	6.4 l	20.2 m
	Average	53.7 A	84.8 BC	15.4 AB	38.1 BC	11.2 AB	10.3 BC	27.7 B	49.1 BC
Chinaberry	0.5	67.3 b	90.5 cd	15.3 b-g	34.8 h	12.3 ab	11.3 cd	35.2 d	52.4 g
M. azedarach	1.0	54.5 fgh	85.0 ef	16.8 abc	45.3 e	12.3 ab	16.5 b	21.2 h	38.8 j
	2.5	41.0 l	77.3 g	19.3 a	60.5 c	14.0 a	23.0 a	9.6 k	23.5 l
	5.0	42.5 l	64.8 i	----	100 a	----	----	0.0 m	0.0 n
	Average	51.3 A	79.4 C	17.1 A	60.1 A	12.8 A	16.9 A	16.5 C	28.7 D
Natgrass	0.5	49.5 ij	97.0 a	12.5 fg	17.5 j	10.5 ab	3.3 gh	38.3 b	77.4 b
C. rotundus	1.0	57.3 def	93.8 b	13.3 d-g	28.5 i	10.0 b	4.8 fg	36.5 c	63.8 d
	2.5	51.8 hij	87.5 de	15.8 b-f	40.3 g	11.0 ab	7.0 ef	25.1 g	48.6 h
	5.0	58.3 de	79.8 g	17.0 abc	57.3 d	12.8 ab	13.3 c	17.2 i	29.6 k
	Average	54.2 A	89.5 B	14.6 B	35.9 C	11.1 AB	7.1 C	29.3 B	54.8 B
Control		52.8 ghi	97.3 a	12.0 g	3.8 k	10.0 b	0.8 h	49.0 a	92.9 a
	Average	52.8 A	97.3 A	12.0 C	3.8 D	10.0 B	0.8 D	49.0 A	92.9 A

* Means followed by the same letters within a column do not significantly appear to be different (at the 0.05 significance level) as determined by Duncan's multiple range test.

eggs was recorded in the aqueous extract of the chinaberry followed by the aqueous extract of the Oleander, the Basil and the Natgrass with a percentage of 79.4, 83.8, 84.8 and 89.5%, respectively.

Also, the results in Table 2. showed that there exists a significant difference in the larval stage period between the treatments of aqueous extracts concentrations and control, and the larval stage period increased as the aqueous extract concentration increased; also the results showed that the larvae failed in the pupation; thus it had not completed its life cycle at the concentration 0.5% of the aqueous extracts of the Oleander and Chinaberry. Also, there exists a significant difference in the larval stage period between the aqueous extracts and control; the highest larval stage period was recorded in the aqueous extract of the Oleander, followed by the aqueous extract of the Chinaberry, the Basil, and the Natgrass with a period of 17.3, 17.1, 15.4 and 14.6 days, respectively. The least larval stage period was recorded in control with 12.0 days. There exists a considerable difference in mortality of larvae among the treatments of Aqueous extracts concentrations, as well as between the treatments of aqueous extracts and control. The larvae mortality increased as the aqueous extract concentration increased. The highest larvae mortality was recorded in the aqueous extract of the chinaberry, followed by the aqueous extract of the Oleander, the Basil, and the Natgrass with a mortality of 60.1, 57.4, 38.1 and 35.9%, respectively, while the least larvae mortality was recorded in control with a mortality of 3.8%.

Furthermore, there exists a considerable difference in the pupal stage period between the treatments of aqueous extracts concentrations and control except for the concentration of 1.0% of the aqueous extract of the Natgrass and concentration of 0.5% of the aqueous extract of the Basil and control which were not significantly different in the pupal stage period. The pupal stage period increased as the aqueous extract concentration increased. There was no significant difference in the pupal stage period between the aqueous extracts of the Olander and the chinaberry and between the aqueous extracts of the Basil and the Natgrass, but there exists a significant difference in the pupal stage period between the aqueous extracts and control. The highest pupal stage period was recorded in the aqueous extract of the Oleander, followed by the aqueous extract of the Chinaberry, the Basil, and Natgrass with a period of 13.0, 12.8, 11.2, and 11.1 days, respectively, while the least pupal stage period was recorded in control with a period of 10.0 days. Also, there exists a considerable difference in mortality of pupae among the treatments of aqueous extracts concentrations per aqueous extract

Table 3. Comparison between ethanolic and aqueous extract effect of some plants on some biological aspects of cowpea beetle *C. maculatus* (Fab.).

Plant species	Type of extract	Mean of biological aspects							
		Number of laid eggs	Percentage of hatched eggs (%)	Larval stage period (day)	Larvae mortality (%)	Pupal stage period (day)	Pupae mortality (%)	Number of emerged adults	percentage of productivity (%)
Oleander	Ethanolic	54.9 A	81.6 A	16.8 A	36.1 B	13.3 A	10.2 B	26.5 A	47.5 A
N.oleander	Aqueous	53.4 A	83.8 A	17.3 A	57.4 A	13.0 A	14.3 A	16.6 B	32.8 B
Basil	Ethanolic	50.9 A	86.1 A	14.1 A	25.8 B	11.0 A	7.0 B	31.6 A	60.4 A
O. basilicum	Aqueous	53.7 A	84.8 A	15.4 A	38.1 A	11.2 A	10.3 A	27.7 A	49.1 A
Chinaberry	Ethanolic	49.6 A	80.5 A	17.3 A	37.0 B	13.4 A	12.2 B	22.3 A	45.2 A
M. azedarach	Aqueous	51.3 A	79.4 A	17.1 A	60.1 A	12.8 A	16.9 A	16.5 A	28.7 B
Natgrass	Ethanolic	53.0 A	88.1 A	13.5 A	21.8 B	11.2 A	4.4 A	36.6 A	66.7 A
C. rotundus	Aqueous	54.2 A	89.5 A	14.6 A	35.9 A	11.1 A	7.1 A	29.3 A	54.8 A

* Means followed by the same letters within a column do not significantly appear to be different (at the 0.05 significance level) as determined by Duncan's multiple range test.

separately and between it and control, and between the treatments of aqueous extracts and control. The pupae mortality increased as the aqueous extract concentration increased. The highest pupae mortality was recorded in the aqueous extract of the chinaberry, followed by the aqueous extract of the Oleander, the Basil, and the Natgrass with a mortality of 16.9, 14.3, 10.3 and 7.1%, respectively, while the least pupae mortality was recorded in control with a mortality of 0.8%.

Also, Table 2 showed a considerable difference in the quantity of emerged adults among the treatments of aqueous extracts concentrations per aqueous extract separately and between it and the control. The number of emerged adults decreased as the aqueous extract concentration increased. Also, there exists a significant difference in the number of emerged adults between the treatments of aqueous extracts and control; the highest number of emerged adults was recorded in control with several 49.0 adults, while the least number of emerged adults was recorded in the aqueous extract of the chinaberry followed by the aqueous extract of the Oleander, the Basil and the Natgrass with several 16.5, 16.6, 27.7 and 29.3 adults, respectively. There is a considerable difference in the percentage of productivity among the treatments of aqueous extract concentrations per aqueous extract separately and between it and control, and the percentage of productivity percentage decreased as the aqueous extract concentration increased. Also, there exists a considerable difference in the percentage of productivity between the treatments of aqueous extracts and control; the highest percentage of productivity was recorded in control with a percentage of 92.9%, while the least percentage of productivity was recorded in the aqueous extract of the chinaberry followed by the aqueous extract of the Oleander, the Basil and the Natgrass with a percentage of 28.7, 32.8, 49.1 and 54.8%, respectively.

Table 4. Germination percentage of the chickpea seeds had been saturated separately with the ethanolic and aqueous extracts concentrations and the untreated chickpea seeds.

Plant species	Conc. (%)	Germination percentage (mean) of the chickpea seeds had been saturated separately with	
		The ethanolic extract	The aqueous extract
Oleander	0.5	100.0 a *	96.7 a
N.oleander	1.0	93.3 a	100.0 a
	2.5	96.7 a	100.0 a
	5.0	93.3 a	93.3 a
	Average	95.8 A	97.5 A
Basil	0.5	100.0 a	100.0 a
O. basilicum	1.0	96.7 a	93.3 a
	2.5	96.7 a	100.0 a
	5.0	93.3 a	100.0 a
	Average	96.7 A	98.3 A
Chinaberry	0.5	96.7 a	100.0 a
M. azedarach	1.0	93.3 a	96.7 a
	2.5	93.3 a	93.3 a
	5.0	96.7 a	93.3 a
	Average	95.0 A	95.8 A
Natgrass	0.5	100.0 a	100.0 a
C. rotundus	1.0	96.7 a	100.0 a
	2.5	100.0 a	93.3 a
	5.0	93.3 a	93.3 a
	Average	97.5 A	96.7 A
Control		100.0 a	100.0 a
	Average	100.0 A	100.0 A

* Means followed by the same letters within a column do not significantly appear to be different (at the 0.05 significance level) as determined by Duncan's multiple range test.

The results in Table 3. showed that there was no considerable difference in the number of laid eggs, percentage of hatched eggs, larval stage period, pupal stage period and number of emerged adults separately between the ethanolic and aqueous extracts of the Oleander, Basil, Chinaberry and Natgrass

except the ethanolic and aqueous extract of the Oleander which were significantly different in the quantity of emerged adults. They showed that the aqueous extracts of the chinaberry had significantly more effect than its ethanolic extract on larval mortality (60.1 and 37.0%, respectively.) and pupal mortality (16.9 and 12.2%, respectively.); At the same time, there was no considerable difference in pupal mortality between the ethanolic and aqueous extracts of the Natgrass. Also, the aqueous extracts of the chinaberry were significantly more effective than its ethanolic extract in reducing the adults' productivity percentage (28.7 and 45.2%, respectively.) compared with the other treatments.

The results in Table 4. showed that there was no considerable difference in germination percentage between the chickpea seeds which had been saturated separately with the ethanolic and aqueous extracts concentrations and the untreated chickpea seeds (in control); in other words, the germination percentage of chickpea seeds were not significantly affected by the concentrations of the ethanolic and aqueous extracts.

DISCUSSION

This study studied the effect of ethanolic extracts of certain plants compared with its aqueous extracts on some biological aspects of cowpea beetle *C. maculatus* (Fab.). According to our findings, chinaberry extracts were the most effective; this superiority may be probably due to its leaves consisting of azadirachtin, terpenoids, triterpenoids, and other substances that have great effects on stored-product insects. Azadirachtin is structurally the same as an insect hormones group, the ecdyosones that control the metamorphosis of larvae into pupae and adult insects. Application of azadirachtin obstructs the production of ecdyosones, preventing molting and the emergence of adults; azadirachtin acts as anti feeding, repellent, sterilant, growth retardant, deterrent of oviposition, and destabilizer of ordinary physiological activities. It is now recognized that azadirachtin and triterpenoid are common pesticides against more than 600 insects, mites, and nematodes, with or without common harmful effects on humans and other mammals. Azadirachtin and triterpenoid affect numerous insects in the orders: Lepidoptera, Coleoptera, Orthoptera, Heteroptera, and Diptera (Csekee*t al*., 2016). According to our findings, the study plants' aqueous extracts were more effective than ethanolic extracts. This superiority may be probably due to the ability of the aqueous extract to penetrability inside chickpea *C. arietinum* L. quickly and deeply compared with ethanolic extracts; thus, there was not enough saturation for chickpea *C. arietinum* L. had been saturated with the ethanolic extracts; therefore larvae of tested insects which fed on chickpea *C. arietinum* L. had been saturated with the ethanolic extracts were affected lowly. Our results have been generally similar to different studies (Izhar-ul-Haq *et al*., 2008; Ahmed *et al*., 1993).

Many plant substances are marked to have insecticidal activities against different insects of stored-product (Cosimi *et al*., 2009; Saroukolai *et al*., 2010). In the light of our results, aqueous extracts uncovered remarkable toxicity against the tested insect. A full mortality had been achieved with a concentration of 5% of aqueous extract of chinaberry and Oleander.

This study found that ethanolic and aqueous extracts of the tested plants affected some biological aspects and considerably decreased the progeny production of the insect studied in the research. Such materials may become indispensable to integrated pest management strategies due to their rife, environment-friendly, and easy application. However, numerous phytochemicals that present control of pest attributes are characterized by possessing harmful properties, side effects, and toxicity dangerous to non-targeted organisms. For example, the oil of neem, which considers a natural insecticide azadirachtin source, possesses an LD_{50} in rats of 14 ml/ mg (Balandrin *et al*., 1985). Despite these problems, the application costs money, the increasing evidence of pesticide resistance, the recorded toxicity dangers resulting in non-targeted organisms, and the environmental drawbacks connected with the chemical control of pests create a vital need for safe, effective, effective, and new pesticides with the selective mode of action. Trials should be guided to evaluate the effectiveness of the plant extracts, powders, or oils under research against various insects of stored-product. Assessments should consider mammalian safety, appropriate formulations for exploitation in grain stores, and insecticidal mode of action.

***Conclusion*:** According to our results we can conclude the following:Superiority of aqueous extracts as compared with ethanolic extracts of the Oleander *Nerium oleander*, Basil *Ocimum basilicum*, Chinaberry *Melia azedarach*, and Natgrass *Cyperus rotundus* leaves as well as superiorityof leaves extracts of Oleander and Chinaberry as compared with leaves extracts of Basil and Natgrass in both types of extraction on some biological aspectsof the cowpea beetle *C. maculatus* (Fab).

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***Availability of data and material*:** We declare that the submitted manuscript is our work, which has not been published before and is not currently being considered for publication elsewhere.

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